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Sputter Deposition of Semiconductor Superlattices for Thermoelectric Applications

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The potential to dramatically improve the thermoelectric properties of materials by using quantum confinement in novel semiconductor nanostructures has lead to considerable interest in the thermoelectric community. We are using magnetron sputtering to explore the critical materials issues in such structures from the thermoelectrics standpoint. We have synthesized structures from thermoelectric materials with bilayer periods of less than 50 angstroms and shown that they are stable even at deposition temperatures high enough to grow quality films. Critical growth issues such as nucleation and growth conditions and their effect on stoichiometry, crystal orientation electronic properties will be discussed. Our work with sputter deposition which is inherently a high rate deposition process also builds the technological base necessary to develop economical production of these materials. High deposition rate is critical since even if efficiencies comparable to CFC based refrigeration systems can be achieved large quantities of nanoscale materials will be necessary to impact the cooling market. We will present experimental results for superlattices in the lead telluride and bismuth telluride families of material. The capability for measurement of the in plane electrical and thermal transport properties in these thin film superlattices has been developed which allows the thermoelectric properties of the films to be well characterized.

The high potential figure of merit of quantum well thermoelectric thin films makes them well suited for both thermal infrared sensors and as coolers to for conventional infrared detectors.

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